

# The Engineer of 2020 Project

A high-risk, high-pay-off approach for the future of U.S. engineering education

-National Academy of Engineering-

Dr. Wayne Clough

President, Georgia Institute of Technology

The American Society for Engineering Education

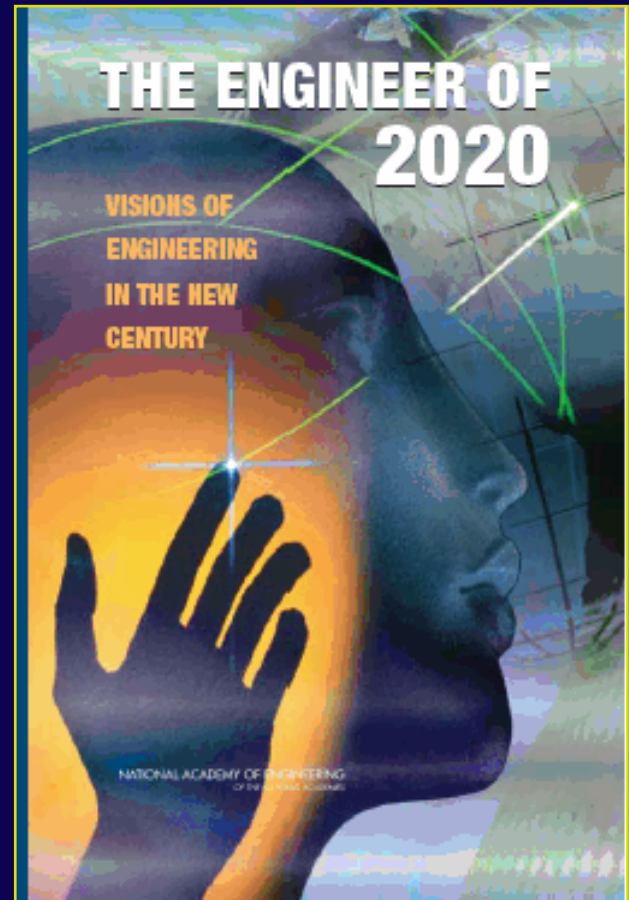
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# The premise

- Past: Engineering and engineering education were reactive, responding to change.
- Today: Rapid change signals that it is time to reverse the paradigm.
- Premise: If we anticipate the future and are proactive about changing engineering and engineering education, we can shape a significant, dynamic role for our profession.

# The process

- Phase I: Imagining the future and the challenges it will present to engineering: Woods Hole Workshop.
- Phase II: Considering how engineering education should prepare for that future: Washington DC Summit.



National Academy of Engineering

# Steering Committees

## Phase I

- Wayne Clough, Chair, Ga Tech
- Alice Agogino, UC Berkeley
- George Campbell, Cooper Union
- James Chavez, Sandia Labs
- David Craig, Reliant Energy
- Jose Cruz, Ohio State
- Peggy Girshman, NPR
- Daniel Hastings, MIT
- Michael Heller, UC San Diego
- Deborah Johnson, U Virginia
- Alan Kay, H-P
- Tarek Khalil, U Miami
- Robert Lucky, Telcordia Technologies
- John Mulvey, Princeton
- Sharon Nunes, IBM
- Sue Rosser, Georgia Tech
- Ernest Smerdon, U Arizona

## Phase II

- Wayne Clough, Chair, Ga Tech
- Alice Agogino, UC Berkeley
- Mark Dean, IBM
- Deborah Grubbe, DuPont
- Randy Hinrichs, Microsoft
- Sherra Kerns, Olin College
- Alfred Moyer, H-P
- Diana Natalicio, UT at El Paso
- Siman Ostrach, Case West Res
- Ernest Smerdon, U Arizona
- Karan Watson, Texas A&M
- David Wisler, GE Aircraft Engines

# Context for engineering



- Breakthroughs in technology
- Demographics
- Challenges
- Economic/societal forces





## Sustainable Technology



Nanotechnology



Biotechnology/  
nanomedicine

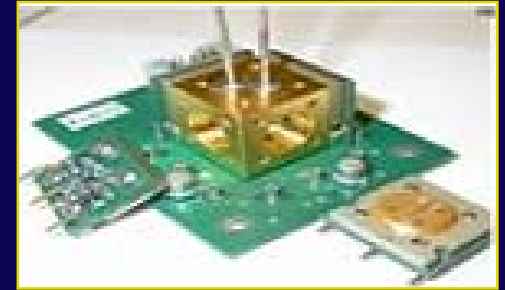


Photonics/optics

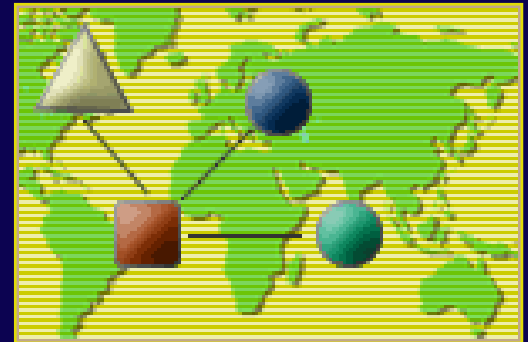


Manufacturing

# Breakthroughs



Microelectronics/  
telecommunications



Logistics



# Demographics

- 8 billion people; a 25% increase since 2000.
- Balance tipped toward urbanization.
- Youth “bulge” in underdeveloped nations while developed nations age.
- If the world condensed to 100 people:
  - ▷ 56 in Asia
  - ▷ 7 in Eastern Europe/Russia
  - ▷ 16 in Africa
  - ▷ 4 in the United States

# Challenges

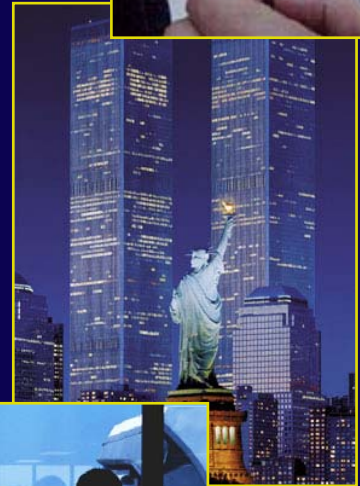
- Fresh water shortages
- Aging infrastructure
- Energy demands
- Global warming
- New diseases
- Security





# Economic/societal forces

- High speed communications / Internet
- Removal of trade barriers
- Terrorist attacks; wars in Iraq, Afghanistan
- Emergence of technology-based economies in other nations
- Sustained investment in higher education in countries like China, India



# Social, global and professional context of engineering practice

- Population is more diverse.
- Social, cultural, political forces will shape and affect the success of technological innovation.
- Consumers will demand higher quality, customization.
- Growing imperative for environmental sustainability.
- Increasing focus on managing risk and assessment with view to security, privacy, and safety.

# Scenario-based planning

- Facilitated by Peter Schwartz, author of "The Art of the Long View"
- Scenarios considered:
  - ▷ The Next Scientific Revolution
  - ▷ The Biotechnology Revolution in a Societal Context
  - ▷ The Natural World Interrupts the Technology
  - ▷ Global Conflict/Globalization



# *Aspirations for the Engineer of 2020*

## Engineering's image

- Public that understands and appreciates the impact of engineering on socio-cultural systems.
- Public that recognizes engineering's ability to address the world's complex and changing challenges.
- Engineers will be well grounded in the humanities, social sciences, and economics as well as science and mathematics.

## *Aspirations for the Engineer of 2020*

# Engineering without boundaries

- Embrace potentialities offered by creativity, innovation, and cross-disciplinary fertilization.
- Broaden influence on public policy and the administration of government, nonprofits, and industry.
- Recruit, nurture and welcome underrepresented groups to engineering.



## *Aspirations for the Engineer of 2020*

# Engineering a sustainable society

- Lead the way toward wise, informed, economical, and sustainable development.
- Assist in the creating of an ethical balance in standard of living for developing and developed countries alike.

## *Aspirations for the Engineer of 2020*

# Educating the engineer of 2020

- Reconstitute engineering curricula and related educational programs to prepare today's engineering students for the careers of the future.
- Create a well-rounded education that prepares students for positions of leadership and a creative and productive life.

# Attributes of the engineer of 2020

- Strong analytical skills.
- Practical ingenuity, creativity; innovator.
- Good communication skills.
- Business, management skills.
- High ethical standards, professionalism.
- Dynamic/agile/resilient/flexible.
- Lifelong learner.
- Able to put problems in their socio-technical and operational context.
- Adaptive leader.

# To succeed

- Attract best and brightest with a forward-looking educational experience – Phase II.
- Educate them to be ready:
  - ▷ To implement new technology.
  - ▷ To focus on innovation.
  - ▷ To understand global trends.



# Thoughts from the Phase II summit

- Some needs have not changed:
  - ▷ A sound grounding in science.
  - ▷ The learning experience of great lectures.
  - ▷ Studio experiences with open-ended problem solving.
- Other things have really changed:
  - ▷ Access to IT creates challenge of coupling deep learning with instant gratification.
  - ▷ Means and ends of using computers to bring the world to campus and enrich learning.
  - ▷ Design tools and sophisticated instruments that enable students to experience the excitement of engineering.

Charles Vest



# Thoughts from the Phase II summit

- Begin the curriculum with “grand challenges.”
- Integrate more directly with the sciences.
- Provide multiple entry points to the curriculum.
- Build working interdisciplinary partnerships.
- Give students self-confidence early on.
- Stop tinkering around the edges and shake things up.

Gretchen Kalonji

# Thoughts from the Phase II summit

- Research/co-op experience with real problems.
- Experience with real-world tools and teams.
- Encourage and recognize diversity.
- Social, ethical aspects of engineering.
- What students learn instead of what we want to teach.
- Creative and practical thinking.

Arden Bement

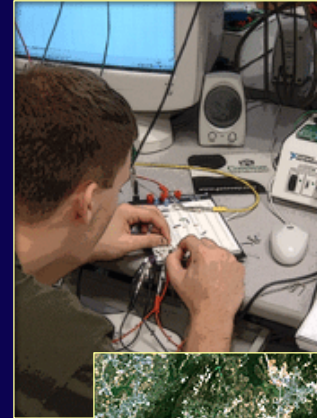
# Highlights from Phase II summit

- Break out of the present mold.
- Education, not just curriculum.
- Career, not just jobs.
- Multiple models, not just one.
- Leadership, not just teamwork.
- More coordination with industry.
- Cross-disciplinary emphasis.



# More highlights from Phase II summit

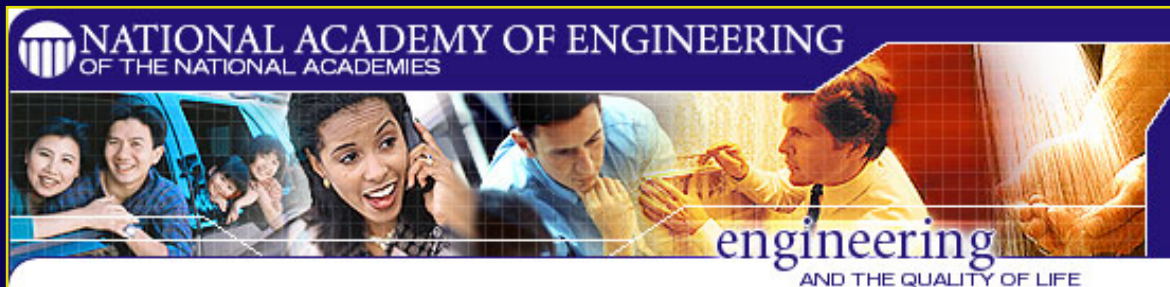
- Emphasis on innovation.
- Systems approach.
- Larger context for engineering and technology.
- Non-engineering career tracks.
- Global perspective.
- Market forces, macroeconomics.
- Sense of urgency.



# Related Initiatives



## National Innovation Initiative

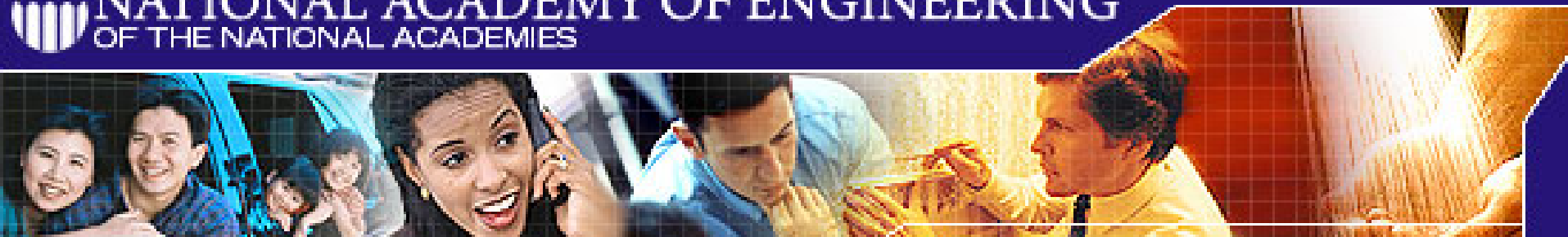


## Frontiers of Engineering Survey



# National Innovation Initiative

- Brought together 400 of the nation's best minds to develop a national innovation agenda.
- National summit, December 2004.
- 30 recommendations in 3 broad areas:
  - ▷ Talent, the human dimension of innovation.
  - ▷ Investment, the financial dimension of innovation.
  - ▷ Infrastructure, the enabling framework of innovation.
- Now proceeding with implementation phase.
- Excellent context for new economic and global realities ([www.compete.org](http://www.compete.org)).

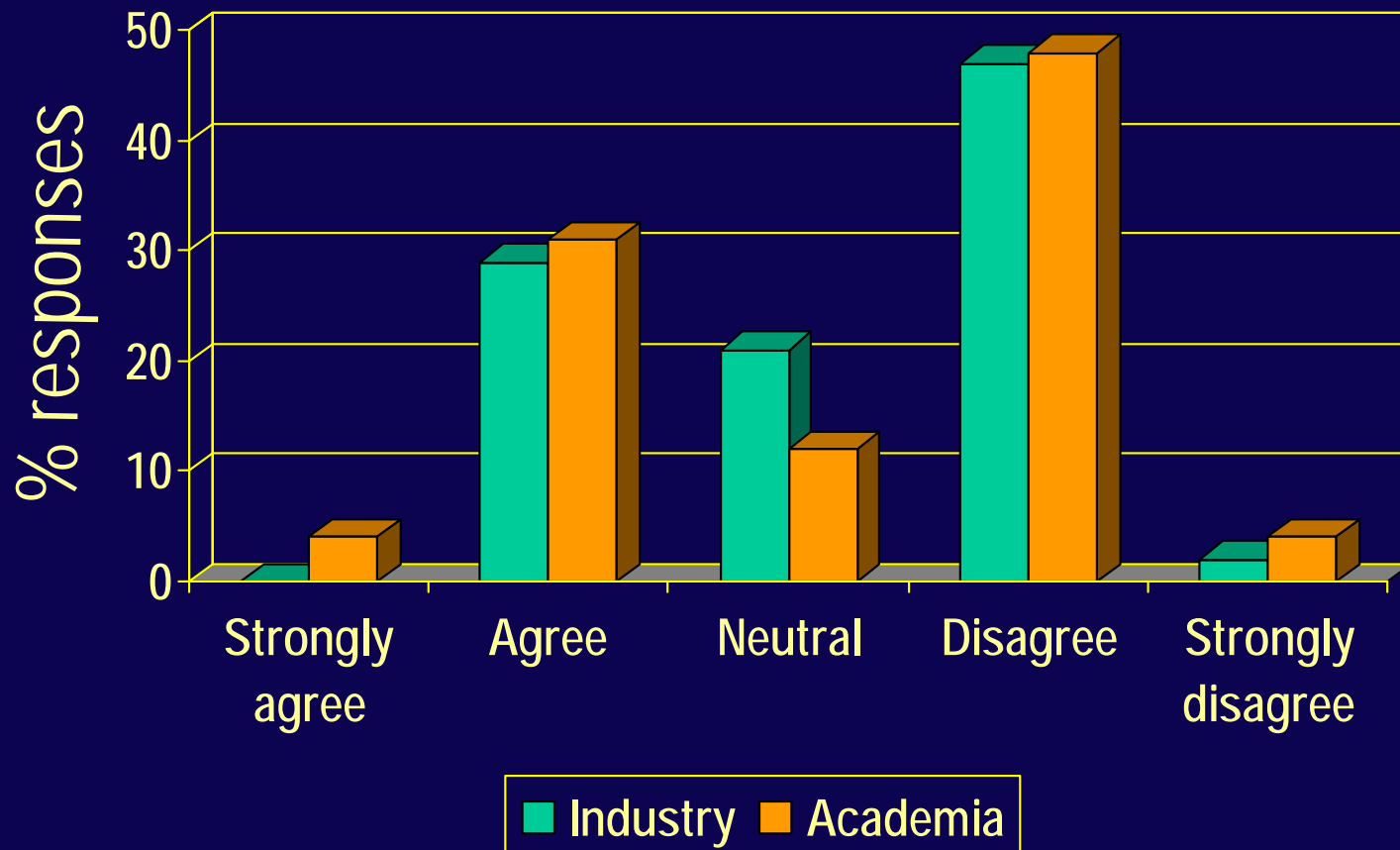


# Frontiers of Engineering survey

- Frontiers of Engineering participants:
  - ▷ Selected as future leaders in engineering.
  - ▷ Ages 30-45 (will still be active in 2020).
  - ▷ 61 respondents from academia, 44 from industry.
  - ▷ Have worked in field for over 10 years.
  - ▷ Involved in cutting-edge engineering topics.
- Intent: assess how well their education prepared them for issues they will face in practice in 2020.

## Frontiers of Engineering

Current undergraduate engineering education is sufficiently flexible to adequately meet the needs of 21<sup>st</sup> century engineers.



# Concluding remarks

- We may have only one chance to achieve our aspirations; that time may be now.
- The momentum generated by the Engineer of 2020 Project should be used to advantage.
- Strategically engage those outside of engineering who are needed to help in our cause.
- Success is tied to innovation and marketing.
- Think as engineer/scientist, not "specialty name here" engineer.
- The future of engineering in the U.S. lies in the balance; engineering education needs to lead the charge to a time of new energy and opportunity.